

INLAND WATERWAY, NORFOLK, VA., TO BEAUFORT
INLET, N. C.—ALLIGATOR RIVER TO NEUSE RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON
PRELIMINARY EXAMINATION AND SURVEY OF INLAND WATER-
WAY FROM NORFOLK, VA., TO BEAUFORT INLET, N. C., WITH A
VIEW TO DETERMINING WHETHER THERE SHOULD BE ANY
CHANGE IN THAT PART OF THE ROUTE FROM ALLIGATOR RIVER
SOUTHWARDLY TO NEUSE RIVER FROM THAT HERETOFORE
RECOMMENDED IN HOUSE DOCUMENT NO. 391, SIXTY-SECOND
CONGRESS, SECOND SESSION, AND HERETOFORE ADOPTED,
AND WHETHER IT WOULD BE DESIRABLE TO EXTEND THE ROUTE
FROM ALLIGATOR RIVER TO PUNGO RIVER, THENCE TO GOOSE
CREEK, THENCE FROM THE HEAD OF GOOSE CREEK TO JONES
BAY, AND THENCE TO NEUSE RIVER, OR WHETHER ANY MODI-
FICATION OF SAID PART OF THE ROUTE IS DESIRABLE.

JANUARY 8, 1915.—Referred to the Committee on Rivers and Harbors and ordered
to be printed, with illustration.

WAR DEPARTMENT,
Washington, January 7, 1915.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit, herewith, a letter from the
Chief of Engineers, United States Army, dated 6th instant, together
with copies of reports from Lieut. Col. E. E. Winslow, Corps of
Engineers, dated June 28, 1913, and September 30, 1914, with map,
a preliminary examination and survey of inland waterway from
Norfolk, Va., to Beaufort Inlet, N. C., made in compliance with the
provisions of the river and harbor act approved March 4, 1913.

Very respectfully,

LINDLEY M. GARRISON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, January 6, 1915.

From: The Chief of Engineers, United States Army.

To: The Secretary of War.

Subject: Preliminary examination and survey of inland waterway from Norfolk, Va., to Beaufort Inlet, N. C.

1. There are submitted herewith for transmission to Congress reports dated June 18, 1913, and September 30, 1914, with map, by Lieut. Col. E. Eveleth Winslow, Corps of Engineers, on preliminary examination and survey authorized by the following item contained in the river and harbor act approved March 4, 1913:

Inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., with a view to determining whether there should be any change in that part of the route from Alligator River southwardly to Neuse River from that heretofore recommended in House Document Numbered Three hundred and ninety-one, Sixty-second Congress, second session, and heretofore adopted, and whether it would be desirable to extend the route from Alligator River to Pungo River, thence to Goose Creek, thence from the head of Goose Creek to Jones Bay, and thence to Neuse River, or whether any modification of said part of the route is desirable.

2. The present authorized route for that part of the Norfolk to Beaufort Inlet waterway from Albemarle Sound southwardly to Neuse River follows successively the Alligator River, a proposed cut across land to Rose Bay, and thence across Pamlico Sound to Neuse River. For a distance of over 20 miles vessels following this route would be exposed to easterly storms and waves having considerable fetch, and the present investigation has in view a change from this route to a more sheltered line. After full study of the question and comparison of available routes, the district officer recommends that a change be made in the adopted route for the inland waterway so that the line will proceed from Alligator River to Pungo River, thence across Pamlico River to Goose Creek, up Goose Creek, and by a land cut to Broad Creek at the entrance to Neuse River. The estimated cost of this portion of the waterway following the line recommended by the district officer is \$2,618,010 for construction and \$50,000 annually for maintenance, as compared with \$2,570,780 for construction and \$50,000 annually for maintenance following the present adopted line. The division engineer concurs in the main with the conclusion of the district officer, but recommends that the line connect with Neuse River through Bay River instead of through Broad Creek. The estimated cost, as thus modified, is \$2,391,880 for construction and \$40,000 for annual maintenance.

3. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated December 9, 1914, concurring in the views of the division engineer.

4. After due consideration of the above-mentioned reports, I concur in the views of the division engineer and the Board of Engineers for Rivers and Harbors, and therefore report that it is deemed advisable to modify the route of the Alligator River-Neuse River section of the inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., so as to follow the Pungo River-Goose Creek-Bay River line approximately as shown on the accompanying map, the estimated cost of which is \$2,391,880 for construction and \$40,000 annually for maintenance.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS
ON SURVEY.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
December 9, 1914.

to the CHIEF OF ENGINEERS, UNITED STATES ARMY.

1. The following is submitted in review of the district officer's reports of preliminary examination and survey of—

Inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., with a view to determining whether there should be any change in that part of the route from Alligator River southwardly to Neuse River from that heretofore recommended in House Document No. 391, Sixty-second Congress, second session, and heretofore adopted, and whether it would be desirable to extend the route from Alligator River to Pungo River, thence to Goose Creek, thence from the head of Goose Creek to Jones Bay, and thence to Neuse River, or whether any modification of said part of the route is desirable.

2. The district officer describes in some detail the various routes that have from time to time been considered and reported upon for the proposed inland waterway from Norfolk to Beaufort and for convenience of reference he divides them into five sections, A, B, C, D, and E. Section A, Norfolk to Albemarle Sound, and sections D and E, Neuse River to Beaufort Harbor and Beaufort Harbor to the ocean, have been definitely located and work on them has been undertaken. This leaves for consideration section B, Albemarle Sound to the line of Pamlico River, and section C, Pamlico River to Neuse River. While the general project for the waterway through these sections has been approved by Congress, no money except for preliminary surveys has as yet been expended on them.

3. After describing the several available routes through these sections and analyzing their advantages and disadvantages, their principal characteristics are summed up in the following table:

	Open route via Croatan and Pamlico Sounds.	Rose Bay route and via cut- off near Brants Island.	Routes via Pungo River and Goose Creek.		
			Jones Bay line.	Bay River line.	Broad Creek line.
Total length.....miles.....	117	97	115	115	111.8
Length of dredged cuts.....do.....	8.4	23.3	32.2	31.3	35.8
Length of land cuts.....do.....	None.	26.3	21.3	23	25
Total length cuts.....do.....	8.4	49.6	54	54.3	60.8
Length in exposed waters of Pamlico Sound and lower Neuse and Pamlico Rivers, miles.....	82	23	12	8	None.
Estimated cost.....	\$183,320	\$2,270,780	\$2,342,660	\$2,391,880	\$2,618,010
Estimated cost of maintenance.....	\$50,000	\$50,000	\$40,000	\$40,000	\$50,000

4. The second route mentioned in this table, Rose Bay route and cut-off near Brant Island, at an estimated cost of \$2,270,780 is the one recommended in the report already approved by Congress. The district officer is of opinion for reasons stated that the Pungo River-Goose Creek, Broad Creek route, at an estimated cost of \$2,618,010 and \$50,000 annually for maintenance, is the best one, and he recommends the adoption of this route. The division engineer commends the Pungo River-Goose Creek-Bay River route at an estimated cost of \$2,391,880 and \$40,000 annually for maintenance.

5. The object of the inland waterway is to secure a safe and sheltered route for vessels of light and moderate draft, avoiding the exposure of the open seas. The least expensive route considered is through the open waters of Croatan and Pamlico Sounds. This route, however, while more sheltered than the open ocean, is still exposed to heavy seas; and the more protected Rose Bay-Brant Island route, at considerably greater cost, was recommended in the report which has been favorably considered by Congress. This route, however, has considerable exposure for a length of about 23 miles, and the purpose of this investigation is to determine whether the object of the inland waterway shall be further advanced by the adoption of a still more sheltered route.

6. The route recommended by the district officer, has practically no exposure, but it costs \$347,230 more for first construction than the adopted route. The estimated cost of maintenance is the same. The route recommended by the division engineer costs \$121,100 more than the adopted route, but \$10,000 less for annual maintenance and has but 8 miles exposure, and this is not severe. Moreover, if this is later found to be objectionable, the Broad Creek section can be added without any change in the rest of the line or abandonment of work already done.

7. After careful study of the questions involved, the board concurs in the views of the division engineer, and recommends as advisable a modification of the adopted route through sections B and C from the Rose Bay-Brant Island route to the Pungo River-Goose Creek-Bay River route, the estimated cost of which is \$2,391,880 and \$40,000 annually for maintenance. It is further recommended that the location of the line as shown on the maps be regarded as approximate only, the exact position being determined when the field work is undertaken.

8. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other subjects so related to the project proposed that they may be coordinated therewith to lessen the cost and compensate the Government for expenditures made in the interests of navigation.

For the board:

W. M. BLACK,
Colonel, Corps of Engineers,
Senior Member of the Board.

PRELIMINARY EXAMINATION OF INLAND WATERWAY FROM
NORFOLK, VA., TO BEAUFORT INLET, N. C.

WAR DEPARTMENT,
ENGINEER OFFICE, UNITED STATES ARMY,
Norfolk, Va., June 28, 1913.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army
(Through the Division Engineer).

Subject: Preliminary examination, change in route, inland waterway from Norfolk, Va., to Beaufort, Inlet, N. C.

1. The river and harbor act approved March 4, 1913, provides for a preliminary examination of the "Inland waterway from Norfolk

a., to Beaufort Inlet, N. C., with a view to determining whether there should be any change in that part of the route from Alligator River southwardly to Neuse River from that heretofore recommended in House Document No. 391, Sixty-second Congress, second session, and heretofore adopted, and whether it would be desirable to extend the route from Alligator River to Pungo River, thence to Goose Creek, thence from the head of Goose Creek to Jones Bay, and thence to Neuse River, or whether any modification of said part of the route is desirable."

2. The provision just quoted provides for an examination with reference to a change of route in a portion of the inland waterway from Norfolk, Va., to Beaufort Inlet, N. C. The entire waterway from Norfolk, Va., to Beaufort Inlet, N. C. is shown on Coast Survey Chart No. 10, and the portion of it specially designated above is shown more in detail on charts 140, 142, 143, 144', and 144''. This portion is shown also on a map¹ based on Coast Survey data and specially prepared to accompany this report.

3. The project for a waterway connecting the waters of Chesapeake Bay and the ocean at Beaufort Inlet, N. C., has been under consideration for almost a century, there being a number of natural waterways which would call attention at once to the possibility of such an inland water route and the great importance of which, especially to small vessels, is that such a waterway avoids the dangers attending the rounding of Capes Hatteras and Lookout.

4. Leaving out of consideration more ancient investigations, the first one leading directly to the project now under way was a provision in the river and harbor act approved June 6, 1900, which required an examination for a 16-foot waterway from the southern terminus of the Dismal Swamp Canal on the Pasquotank River, through Albemarle, Croatan, Pamlico, and Core Sounds, to Beaufort Inlet. The report on this examination was published in House Document No. 12, Fifty-sixth Congress, second session (repeated in the Annual Report of the Chief of Engineers for 1901, p. 1511), and was to the effect that, though the general project was a worthy one, it was very doubtful if the route designated by the act was the best and the most desirable one to be followed.

5. The river and harbor act approved June 13, 1902, provided for another examination and survey by a board of Engineer officers (hereafter referred to as the 1902 Board) of the "Waterway from Norfolk, Va., to Beaufort Inlet, N. C., with a view to the construction of a channel not less than 16 feet in depth upon the most advantageous route between the points named." The report on this examination was published in House Document No. 563, Fifty-eighth Congress, second session, and was repeated in the Annual Report of the Chief of Engineers for 1904, page 1387.

6. The report of the board of officers, required by the act just quoted, discussed the relative advantages and costs of the various possible routes for the waterway and recommended the construction of the waterway along a certain specified route at an estimated cost of about \$10,000,000. As required by law, this report of the special board was referred to the Board of Engineers for Rivers and Harbors, and after consideration this latter Board submitted a report to the

¹ Not printed.

effect that the commercial and military advantages of such a waterway were not, in its opinion, sufficient to justify the cost of a 16-foot waterway, but that they were probably sufficient to justify a waterway of lesser depth, and as (by the wording of the act under which the report was submitted) a 16-foot waterway only could be considered the Board of Engineers for Rivers and Harbors recommended that Congress authorize a new inquiry as to the best route and the cost of a waterway having a depth of 10 or 12 feet.

7. By the river and harbor act approved March 3, 1905, Congress again directed an examination and survey by a new board of Engineer officers of the "Inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., with a view to obtaining a channel of a depth of 10 and 12 feet, respectively, upon the most advantageous route between the points named."

8. The report on the examination and survey required by the act just quoted was published in House Document No. 84, Fifty-ninth Congress, second session. The Board (which will hereinafter be referred to as the 1905 Board) recommended as advisable the project for an inland waterway 12 feet in depth, but the route selected was conditional upon whether or not the Albemarle & Chesapeake Canal could be purchased for a sum not exceeding \$500,000.

9. The subject of the waterway from Norfolk, Va., to Beaufort Inlet, N. C., was again included in a provision of the river and harbor act approved March 3, 1909, as a part of a project for a general intra-coastal waterway from Boston, Mass., to the Rio Grande River, Tex.

10. The report of the board of officers on the portion of the intra-coastal waterway between Boston, Mass., and Beaufort, N. C. (hereinafter referred to as the 1909 Board), was published in House Document No. 391, Sixty-second Congress, second session. This report in so far as relates to the portion from Norfolk to Beaufort, recommended the adoption of a waterway 12 feet in depth along a specific route at an estimated cost of \$5,400,000, including the purchase of the Albemarle & Chesapeake Canal at the cost of \$500,000.

11. The project just referred to was formally adopted by Congress by the act of July 25, 1912, and constitutes the adopted project for the whole waterway, though Congress had already formally adopted projects for certain sections of this waterway.

12. By the river and harbor act approved March 3, 1905, Congress formally adopted a project for a channel at Beaufort Inlet, N. C., 30 feet wide and 20 feet deep at mean low water, in accordance with the plan recommended by the 1902 Board, above referred to. The project has been completed.

13. By the river and harbor act approved March 2, 1907, Congress formally adopted a project for a waterway, 10 feet deep at low water from the Neuse River to Beaufort Harbor by way of Adams and Crockett Creeks, in accordance with the project recommended by the 1902 board, and along the route recommended also by the 1902 board. This project has been completed and this portion of the waterway now in use.

14. The 1905 board having recommended the selection of the Albemarle & Chesapeake Canal route for the portion of the canal near Norfolk, if this canal could be purchased by the United States for not exceeding \$500,000, Congress by the act approved June 25, 1911, authorized the Secretary of War to enter into negotiations for the

purchase of the Albemarle & Chesapeake Canal and its appurtenant property, but directed that no contract for the purchase of the canal should be entered into unless it was recommended by the 1909 board. Said board having recommended the purchase of the canal for the price mentioned above and the canal company having agreed to this price, a contract was on the 17th day of February, 1912, entered into between the Secretary of War and the canal company for the purchase of said canal, and by the act approved July 25, 1912, Congress made a specific appropriation of \$500,000 for this purchase. After an examination of the title of the canal company to the land claimed to be owned by it, the purchase of the canal was consummated on April 30, 1913, and the canal, formerly a private toll canal, was opened as a free public waterway from Norfolk Harbor through certain natural waterways and two land cuts to North River, which empties into the northeast corner of Albemarle Sound. This makes available a free waterway all the way from Norfolk to Beaufort with present least depth of about 8 feet.

SECTIONS OF WATERWAY.

15. The entire waterway between Norfolk, Va., and the ocean at Beaufort Inlet, N. C., can, for convenience in consideration, be divided into five sections:

- (A) Norfolk to Albemarle Sound.
- (B) Albemarle Sound to the line of Pamlico River.
- (C) Pamlico River to Neuse River.
- (D) Neuse River to Beaufort Harbor.
- (E) Beaufort Harbor to the ocean.

16. Through all of these sections, except section E, several alternative routes were possible, but as has been stated above, Congress has already taken action which has definitely fixed the routes for sections A and D.

17. By the approval of the report of the 1909 board, routes for the parts of the waterway in sections B and C have been formally selected, but no money other than for preliminary surveys has as yet been spent on either of these sections, and nothing has been done to definitely fix the routes therein. Only preliminary surveys have been made of the different routes, and the different boards which have attempted to select the routes in these sections have been compelled to base their reports upon incomplete data, and in consequence, as was to be expected, they have not all been of the same opinion. The opening of the question of choosing the routes in these two sections would, therefore, appear to be advisable and is provided for in the portion of the act approved March 4, 1913, quoted at the beginning of this report.

SECTION B.

ALBEMARLE SOUND TO THE LINE OF PAMLICO RIVER.

18. As will be noted from the map, there is now available through this section a natural waterway passing from the east end of Albemarle Sound, through Croatan Sound and along Pamlico Sound, to opposite the mouth of Pamlico River. This route, though there now exists through it a channel about 9 feet deep at low water, has, as

will be noted below, many disadvantages, and other alternative routes have been investigated, all of which proceed from Albemarle Sound up the straight and broad portion of the Alligator River to opposite a point called Newport News.

19. From a common point in Alligator River, near Newport News Point, a number of routes are possible, all containing land cuts greater or less length and reaching to certain bays or rivers tributary to Pamlico Sound or River. Two of these routes—the Long Shoal route and the Far Creek route—extend southeastwardly, and one—the Wysocking route—extends southwardly, all three to tributary bays on the northwestern shore of Pamlico Sound. Two—the Juniper Bay and Swan Quarter routes—extend southwestwardly through Lake Mattamuskeet to bays on the north shore of Pamlico Sound and two—the Rose Bay and Pungo River routes—pass to the west of Lake Mattamuskeet and thence through rivers or bays to Pamlico River.

20. All the above routes, except that by Pungo River, are described somewhat at length in the report of the 1902 board. The report of the 1905 board discusses the same routes more or less at length and adds the Pungo River route. The report of the 1909 board refers to all the above and suggests a modified Pungo River route.

21. The 1902 board, restricting its consideration to a 16-foot waterway, selected the Rose Bay route. The 1905 board selected the Croatan Sound route for a 10-foot waterway and tentatively for a 12-foot waterway, but of the Alligator River routes preferred the Pungo River route to the Rose Bay route. The 1909 board again selected the Rose Bay route, this time for a 12-foot waterway.

22. These different routes will now be discussed briefly, but in somewhat greater detail.

23. *Croatan Sound route.*—Croatan Sound lies between Roanoke Island on the east and the mainland on the west and connects Albemarle Sound on the north with Pamlico Sound on the south; it is about 3 miles wide and 12 miles long. The bottom of this sound is very irregular, deep pockets and shoals being scattered in confusion, depths as great as 6 fathoms existing close to shoals having a depth less than 6 feet.

24. There is now throughout the length of Croatan Sound an available channel not less than 9 feet in depth, but to obtain a channel 12 feet deep would require dredging over a total length of about 12 miles, and as a considerable portion of this would be merely skimming the bottom, the cost per cubic yard would be high. The bottom of Croatan Sound seems to consist generally of sand, which shifts readily, as was shown by an attempt some years ago to dredge a channel through a portion of the sound. The channel was made 12 feet deep and about 200 feet wide, but the cut was soon obliterated and an examination made a few years later showed no trace of the work.

25. The portion of Pamlico Sound traversed by this route is very wide and generally very deep. There is, however, across it a long narrow sand reef, extending from the mainland near Bluff Point to Ocracoke Inlet. This sand reef is known as "Bluff Shoal," and the available depth across it appears not to exceed about 10 feet. The distance between 12-foot contours is about nine-tenths of a mile.

26. The great disadvantage of a route through Pamlico Sound is the exposure to storms and winds. The sound has a maximum

width of about 25 miles, it is separated from the ocean by a low narrow sand strip, and the shore on the mainland side is also low, consequently there is nothing to break the force of the wind, and the sound is therefore open to the full force of the wind and the violent storms for which the vicinity of Cape Hatteras is famous.

27. Although the project under consideration is for a waterway 12 feet deep only, it is believed proper in selecting the route for this waterway that consideration should be given to a possible future increase in depth; and if this increase should be to a depth of 16 feet there would be required by the Croatan route, dredging for about 40 miles, from deep water in Albemarle Sound through Croatan Sound to deep water in Pamlico Sound, and for not less than 2 miles across Bluff Shoal.

28. While the work necessary to obtain a 12-foot waterway through the Croatan route would be low in first cost as compared with any one of the Alligator River routes, the probable difficulty and high cost of maintaining the cuts through the shifting sand bottom, the exposure of Pamlico Sound to storms, and the great cost of increasing the depth of the waterway, should it be desired in the future, have generally been considered by the boards who have previously considered the subject to outweigh the advantage of the low initial cost of this route.

29. *Alligator River routes.*—All the other routes in this section pass up the Alligator River. This river for 20 miles upstream is from 2 to 4 miles wide and from 9 to 15 feet in depth. The bottom is sandy and the water contains practically no sediment. The land immediately surrounding Alligator River, especially to the eastward, is extremely low and swampy and thickly timbered.

30. *Long Shoal, Far Creek, and Wysocking routes.*—All three of these routes contain land cuts from Alligator River to bays on the northwest shore of Pamlico Sound. The Long Shoal route has the shortest land cut, and in fact there is at present, between Alligator River and Long Shoal River, a narrow and tortuous passage available for skiffs. The Far Creek line, though slightly longer in the land cut than the Long Shoal route, is the most direct to deep water in Pamlico Sound. The Wysocking route has a longer land cut than either and enters Pamlico Sound just north of Bluff Shoal.

31. All three of these routes have the disadvantage of passing through a large portion of the open waters of Pamlico Sound, and therefore of exposure to storms. Compared with the Croatan route, they would be much more expensive for a 12-foot waterway and about as expensive for a 16-foot waterway, and their exposure would be practically as great.

32. *Juniper Bay and Swan Quarter routes.*—Both of these routes extend from Alligator River to Lake Mattamuskeet through a portion of that lake, and thence by land cuts to the bays which give their names, respectively, to the routes.

33. *Lake Mattamuskeet.*—Lake Mattamuskeet is a large but shallow body of fresh water and was formerly about 16 miles long and about 6 miles wide. It is surrounded by a rimlike ridge about 4 to 6 feet above sound level. The crest of this ridge is about 100 yards from the bluff marking the real shore of the lake, and on the outside the elevation of the rim decreases gradually to that of the surrounding swamp. The level of the water in this lake has always been dependent

to some extent upon the rainfall, and occasionally in its natural condition used to overflow its rim. As a whole, the lake was very shallow, the deepest portion of the bottom being not more than 3 or 4 feet below the surface level of Pamlico Sound and considerable areas being at or above the surface level of that sound. In order to render available for cultivation the fertile bottom of the lake, drainage canals were cut from the lake to the sound. These have caused the lowering of the lake level and a diminution in its size, and it is understood that work is about to be begun on a comprehensive project having in view the reclamation by draining and pumping of practically the entire bottom of the lake.

34. The two routes now under discussion, which pass through the lake, would both require extremely long land cuts, since the draining of the lake has turned the lake into dry land; furthermore, as far as the rim of the lake is concerned, these cuts would be through land higher than the average in this vicinity, and through areas so fertile and valuable as to justify expensive and extensive reclamation schemes, consequently these routes would be expensive in the costs of right of way and damages.

35. Both of these routes debouch on the north shore of Pamlico Sound westward of Bluff Shoal, and therefore pass, before the mouth of the Neuse River is reached, through a very exposed portion of Pamlico Sound.

36. *Rose Bay and Pungo routes.*—These two routes are much alike. They debouch from Alligator River at or a short distance to the left of Newport News Point and pass by land cuts westward of the rim of Lake Mattamuskeet to bays on Pamlico River. The land through which these cuts run is generally low and was at one time all thickly timbered, but there are now fairly large areas where the timber has been burnt out leaving open savannas.

37. These routes enter Pamlico River above the point where this river empties into the sound and in places which are therefore quite well protected from storms.

38. As the protected character of these two routes is the greatest advantage that they possess over the other routes above considered and as the full advantage of protection can only be obtained by continuing the routes by similar protected routes in section C, it would appear to be well to postpone a further discussion of these routes until the different routes possible in section C have been outlined.

SECTION C.

PAMLICO RIVER TO NEUSE RIVER.

39. This section of the waterway extends from the line of the Pamlico River to the center of Neuse River opposite the mouth of Adam Creek, the starting point of the new waterway recently complete from the Neuse River to Beaufort Harbor.

40. The lower part of Neuse River flows northeastwardly into Pamlico Sound and forms a practical extension of the axis of the sound. This portion of the Neuse River is from 3 to 4 miles wide and through its center is a wide channel from 17 to 22 feet deep.

41. The left bank of the Neuse River, except for the indentation caused by bays, is extended in a fairly straight line to Pamlico Point.

which marks the end of the right bank of the Pamlico River. From this shore there is a submerged narrow sand bar projecting northwardly into Pamlico Sound, and marked at its extremity by the Brant Island Shoal Lighthouse, some 14 miles offshore. The depth of water along the crest of this shoal varies from about 2 to 7 feet, and at one place, about 4 miles from the mainland, there is a small island known as Brant Island, which gives its name to the shoal.

42. On the north side of this shoal, following down the center of Pamlico River, there is a wide channel fully 20 feet in depth, and the same is true of the channel from the Neuse River south of this shoal, so that through the whole of section C there is at present, without any work being done, a wide and deep channel passing around the Brant Island Lighthouse. This route will, in this discussion, be called the "lighthouse" route.

43. *Lighthouse route.*—Should there be finally selected for section B of the waterway either the Croatan route or any one of the Alligator River routes debouching into Pamlico Sound northeast of Bluff Shoal, there is no question but that the lighthouse route is the proper one to select for section C, as it is the most direct route, and passes over wide and deep water where sailing could be resorted to, and the portion of the lower Neuse River traversed is by no means as much exposed as the parts of Pamlico Sound which must have already been passed over.

44. *Brant Island Cut-off route.*—Should either the Juniper Bay route or Swan Quarter route or any of the routes debouching on the Pamlico River be selected for section B, a route around Brant Island Shoal Lighthouse requires a longer detour and in water much exposed to storms and wind, and as it is desirable, if practicable, to avoid as much of this wide detour and exposure as possible an alternative route by a short cut across Brant Island Shoal has been suggested.

45. About halfway between Brant Island and the lighthouse charts show a slough through the shoal, having a depth of 6 or 7 feet, and quite close to Brant Island there is a depression in the shoal which could at not very great expense be deepened into a 12-foot channel.

46. By making the cut-off just mentioned the saving of distance in connection with the Juniper Bay route would be 5 miles and with the Rose Bay or Pungo routes 12 miles. A cut-off of this character in connection with the Rose Bay route is suggested by the 1902 board.

47. *Goose Creek-Jones Bay route.*—If the Rose Bay or Pungo River route be selected in section B, the entire route from Norfolk as far as Pamlico River, with the slight exception of the crossing of Albemarle Sound, will be in water thoroughly protected from storms and heavy winds, and it might be considered desirable to continue this protection by substituting for the exposed routes around the lighthouse or through the Brant Island Cut-off a land cut from one of the creeks emptying in the south side of Pamlico River to one of the creeks or bays emptying into the northwest side of Neuse River.

48. Such is the Goose Creek-Jones Bay route as specified in the text quoted at the beginning of this report. This route proceeds from Pamlico River up the wider and straighter portions of Goose Creek, and thence by a land cut to the head of Jones Bay and down this bay to Pamlico Sound near the mouth of Neuse River. This route avoids a considerable portion of the exposure required by the Brant Island Cut-off route, but even it debouches into Pamlico Sound

and requires a passage through some 6 or 7 miles of water much exposed to northeast and easterly winds before the protected portion of Neuse River is reached.

49. *Goose Creek-Bay River route.*—The object of the Goose Creek-Jones Bay route being apparently to avoid exposure in passing from the Pamlico River to the Neuse River, and this route accomplishing this object only in part, it might appear desirable to ascertain if it be not possible by making use of bays to the southward of Jones Bay to obtain a more protected route, which would avoid the exposure between Jones Bay and the Neuse River.

50. This would apparently be accomplished by extending still farther south the land cut necessary to reach to Jones Bay, which would bring this land cut into Bay River. Bay River is much larger than Jones Bay, is much deeper and wider and empties farther west and would appear, therefore, to possess many advantages over Jones Bay.

51. In fact, if still further protection is considered necessary it is possible to continue up a deep bay on the south side of Bay River, and by making a short cut through the marsh reach the north bank of the Neuse River, well inside of its mouth.

52. *Comparison of routes.*—The following is a discussion and comparison of the Rose Bay and Pungo River routes in connection with an extension via Goose Creek.

53. The Rose Bay route was recommended by the 1902 board because taking into account safety, distance, and cost, this route offered the most advantageous combination of these three considerations. It is neither the cheapest nor the shortest route, but a smaller part of it lies in exposed water than any of the other routes considered. This was in connection with the consideration of a 16-foot waterway and the Pungo River route was not considered.

54. The Pungo River route was first considered by the 1905 board in connection with a 12-foot waterway, and even in connection with the route across Brant Island Shoal the board considered this route cheaper and preferable to the Rose Bay route, although it was some 16 miles longer.

55. On the other hand, the 1909 board, in the comparison of the Pungo River and the Rose Bay routes, chose the Rose Bay route because the Pungo River route though cheaper was longer, but this recommendation was in connection with either the "lighthouse" or "cut-off" routes in section C.

56. The Rose Bay and Pungo River routes are very similar; the country they pass through is essentially the same. Between Alligator River and Pamlico River the Rose Bay route is slightly the shorter but the land cut is several miles longer. The greater part of Pungo River is of sufficient depth, while considerable dredging will be needed in Rose Bay.

57. The shores of Rose Bay are thinly settled and there is no town of any importance on this bay. On the Pungo River, on the other hand, there is the town of Belhaven, having rail connection by the Norfolk Southern Railroad, and presumably, therefore, the Pungo River route would be of more local value than the Rose Bay route.

58. Starting from Newport News Point, in the Alligator River, and extending to the mouth of Goose Creek, the distance by the Rose Bay route is as follows:

	Miles.
Alligator River.....	1.6
Land cut.....	26.3
Dredging in Rose Bay.....	2.9
Deep water in Rose Bay and across Pamlico River to mouth of Goose Creek....	10.8
Total.....	42.6

Between the same points by way of the Pungo River route, the distances are as follows:

	Miles.
Alligator River.....	4.6
Land cut.....	20.5
Dredging to Pungo River.....	1.5
Dredging in Pungo River.....	1.7
Deep water in Pungo River and Pamlico River.....	19.5
Total.....	47.8

59. In connection with the previous examinations two or three survey lines have been run from the Alligator River to Rose Bay or Pungo River, but these surveys consisted merely of level and traverse lines, run in a predetermined direction, and it is by no means certain that any of these lines passed over the best possible route, and it is believed important that before the great expense of making the long land cut is undertaken, additional surveys be made to determine the best location for this land cut, and whether or not it should extend to Rose Bay or Pungo River.

60. The act quoted at the beginning of this report directs the consideration of a possible route up Goose Creek and across to and down Jones Bay. The river and harbor act approved July 25, 1912, provided for a preliminary examination for such a waterway, and the report on this examination, which was unfavorable, was published as House Document No. 38, Sixty-third Congress, first session. From the reading of this report, consideration was evidently given the matter as an independent proposition, and not as a portion of the inland waterway. Considered independently, the project is doubtless of great value, but considered as a portion of the inland waterway, it is believed to be worthy of further consideration.

61. The lower part of Goose Creek is fairly straight and of almost sufficient depth; thence the route would be about a mile up Upper Spring Creek, a creek now 8 or 9 feet in depth and with marshy banks; thence through a prong of this creek and by a land cut less than 2 miles long to Jones Bay, the elevation along this cut averaging about 10 feet above the low-water plane.

62. Jones Bay has near its mouth a channel more than 12 feet in depth, but from the point where this land cut enters it, not less than 3 miles of dredging would be necessary before the natural depth of 12 feet is encountered.

63. As has been stated before, the Jones Bay route has the disadvantage of emptying into an exposed portion of Pamlico Sound, and it would appear to be desirable not to end the land cut at Jones Bay, but to extend it across to one of the tributaries of Bay River. From Jones Bay to the head of Beef Creek, a tributary of Bay River, would appear from the maps to be less than 1 mile, with the intervening land low and swampy. Beef Creek empties into Gales Creek, and Gales Creek into Bay River at a point where the depth naturally exceeds 12 feet. In fact the total dredged distance to Bay River

would appear to be no more than that by going through Jones Bay, but the data available is too incomplete to render possible a close estimate of the relative costs of the two routes. The total length by passing over the two routes between a common point in Goose Creek and a common point in Neuse River would appear to be about the same, and Bay River would undoubtedly have the advantage of decreasing the distance of exposed water to be traversed. It is believed that as compared with Jones Bay, the apparent merits of the Bay River route render its investigation advisable.

64. Another modification in the route could be made which would obviate all exposed navigation in Pamlico Sound. This modification consists, instead of going down Bay River, in crossing Bay River to Bonners Bay and proceeding up Bonners Bay, and thence, by a land cut, in low and swampy country, and in one of two or three possible directions, to debouche in Broad Creek which empties into Neuse River west of Neuse River Light, and thus avoids the whole of Pamlico Sound. Such a route, while increasing the length of the cut through land, diminishes the total length of the waterway by about 4 miles, and obviates all exposed navigation.

65. The total distance from the Alligator River via Rose Bay through Brant Island Cut-off Channel to the Neuse River, opposite the mouth of Adams Creek, would be about 68 miles. By going up Goose Creek and crossing either to Jones Bay or Bay River the distance is increased to about $82\frac{1}{2}$ miles, but a reduction of 4 miles of this latter distance can be made by the extension of the land cut westward of Bay River as noted above. By Pungo River instead of by Rose Bay, the distance over each of the routes would be about 5 miles greater.

66. The above outlines of the different possible routes between the mouth of Goose Creek and Neuse River are of course tentative. Further study and investigation would be necessary to determine which one would be the most advantageous from the standpoints of economy, time, and safety. Departures from the suggested course would probably be found necessary on further study and examination, but this discussion shows the possibility of an inland route that would avoid the difficulties attending on Brant Island Shoal.

67. Congress having already decided upon the construction of the waterway, and the routes having been fixed in three of the five sections, the only point now to be considered is the selection of the best route in sections B and C, and, in my opinion, sufficient data has now been obtained to determine what is the best route in these sections, and I therefore recommend that authority be given to make such additional surveys as may be necessary to determine—

First. The most advantageous route from Alligator River to Pamlico River, and whether this most advantageous route should enter Pamlico River by Rose Bay or Pungo River.

Second. To determine the cost and advisability of extending the waterway from Goose Creek and across to Jones Bay.

Third. To determine the cost and advisability of routing the waterway further westward by Bay River or beyond.

Fourth. And by comparison of the data obtained by these surveys to determine between the advisability of following the natural waterways now open or of constructing a new waterway further inland by the routes that have been mentioned.

68. Except at Belhaven, as noted, there are no railroad terminations affecting this portion of the waterway, and such wharves as exist

for local use only. None of the waterways mentioned are subject to freshets, and no questions of water power are involved in this waterway. The waterways involved are practically nontidal, the elevation of water surface being influenced by winds.

E. EVELETH WINSLOW,
Lieut. Col., Corps of Engineers.

[First indorsement.]

OFFICE DIVISION ENGINEER, SOUTHEAST DIVISION,
June 30, 1913.

to the CHIEF OF ENGINEERS.

1. We have here a great many different routes, each possessing certain advantages and disadvantages of its own. They have been examined at different times and under different circumstances and with different degrees of thoroughness, and it is not practical to make a satisfactory comparison of them all. Such a survey should now be made as to make it possible to find out which is the best route, all things considered. First cost is a matter of prime importance, the shortness of the route is also another important consideration, ease of maintenance is another, the shelter which it affords another and all these things can only be told by a survey properly planned for the purpose.

2. I would recommend that the necessary allotment be made from the appropriation for "Examinations, surveys, and contingencies."

DAN C. KINGMAN,
Colonel, Corps of Engineers.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
August 12, 1913.

to the CHIEF OF ENGINEERS, UNITED STATES ARMY.

1. For reasons stated herein, the board concurs with the district officer and the division engineer in recommending a survey in order to determine the advisability of a change in location of this waterway between Albemarle Sound and Neuse River.

For the Board:

W. M. BLACK,
*Colonel, Corps of Engineers,
Senior Member of the Board.*

SURVEY OF INLAND WATERWAY FROM NORFOLK, VA., TO BEAUFORT INLET, N. C.

WAR DEPARTMENT,
ENGINEER OFFICE, UNITED STATES ARMY,
Norfolk, Va., September 30, 1914.

From: The District Engineer Officer.

To: The Chief of Engineers, United States Army
(Through the Division Engineer).

Subject: Report on survey on change in route, inland waterway from Norfolk, Va., to Beaufort Inlet, N. C.

1. This report on a survey is submitted in compliance with the Department's instructions dated August 20, 1913, and is supplemental to the report submitted by this office under date of June 28, 1913,

upon a preliminary examination made in accordance with the following provision in the river and harbor act approved March 4, 1913

Inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., with a view to determining whether there should be any change in that part of the route from Alligator River southwardly to the Neuse River from that heretofore recommended in House Document No. 391, Sixty-second Congress, second session, and heretofore adopted and whether it would be desirable to extend the route from Alligator River to Pung River, thence to Goose Creek, thence from the head of Goose Creek to Jones Bay and thence to Neuse River, or whether any modification of said part of the route is desirable.

2. As stated in the report on preliminary examination, the inland waterway from Norfolk, Va., to Beaufort Inlet, N. C., forms part of the proposed intracoastal waterway from Boston, Mass., to the Rio Grande, which, as far as the portion of the route between Norfolk, Va., and Albemarle Sound, N. C., is concerned, has been formally adopted by Congress. Appropriations have been made and work has been begun.

3. There are submitted with this report a general map of the waterway from Norfolk, Va., to Beaufort Inlet, N. C., and four maps giving in detail the results of the survey upon which this is a report. The United States Coast and Geodetic Survey chart No. 10 illustrates in a general way the territory through which the waterway extends and charts Nos. 140, 142, 143, 144¹, and 144² of the same survey show in considerable detail the natural waterways utilized.

4. Throughout this report all depths and elevations are referred to mean low water and all quantities are place measurement. A bottom width of 90 feet with slopes of 1 on 3 is used in estimating the quantities in land cuts. Dredged channels in narrow rivers are given a bottom width of 125 feet, while channels in wider waters are given bottom widths of 200 and 250 feet, with side slopes of 1 on 3. One foot of overdepth has been allowed in all computations of quantities of excavation. In laying out curves a minimum radius of 2,000 feet has been employed.

5. The report on preliminary examination reviewed the history of the project and described the several routes which have been proposed from time to time. For convenience in study and discussion in this same report considered the waterway in the following five parts:

- (A) Norfolk to Albemarle Sound.
- (B) Albemarle Sound to the line of Pamlico River.
- (C) Pamlico River to Neuse River.
- (D) Neuse River to Beaufort Harbor.
- (E) Beaufort Harbor to the ocean.

6. As the routes in the parts designated A, D, and E have been definitely fixed by the action of Congress and by the beginning of actual construction, and as the item in the river and harbor act directing the examination, specially limits it to the part of the route between the Alligator River and Neuse River, only the portions of the waterway included under B and C have been examined and surveyed.

¹ Not printed.

SECTION B.

7. Section B extends from Albemarle Sound to the line of Pamlico River. As stated in the preliminary examination and in other reports previous to that, there already exists a natural water route through this section proceeding by way of Croatan and Pamlico Sounds to the mouth of the Pamlico River. There are a number of alternative lines which proceed up the wide portion of the Alligator River. From the head of the wide portion of the Alligator River a number of lines have been considered through the remainder of this section, but of all of these, only two are now in question; one by a land cut to Rose Bay and then down this river to Pamlico Sound; the other by a land cut to Pungo River and down this river to Pamlico River. Of these two mentioned land cuts, the former is that quoted in the report which was formally adopted by Congress and may therefore be considered as the adopted route. The other is the one named in the act directing this new examination and survey.

8. In section B the characteristics of the first or Croatan route can be obtained, without surveys, from Coast Survey data. The land cut from Alligator River to Rose Bay has been well surveyed some years ago, and the surveys in this section at the present time were therefore restricted to the determination of the cost of an advisable line from the Alligator River to and down the Pungo River.

9. The Croatan route has at present a least available depth of about 9 feet and depths less than 12 feet (that of the adopted project) are to be found throughout nearly the whole length of Croatan Sound and across what is known as Bluff Shoal in Pamlico Sound. In 1909 the Board of Engineers estimated the cost of providing a 12-foot channel through these shoals at \$183,380. This is by far the cheapest route.

10. However, as stated in the preliminary examination, the shoalest depths are found in Croatan Sound, where the sand on the bottom shifts rapidly and where experience has shown that dredged channels rapidly disappear. Furthermore, vessels following this route have to pass through the whole length of Pamlico Sound and are much exposed to storms there, which frequently are of such violence as to force the smaller vessels to run to shelter.

11. On account of this exposure and the probable high cost of maintenance, the boards which have considered this subject have almost uniformly reported in favor of a more protected route by way of Alligator River, even though this involved a land cut.

12. The Rose Bay and the Pungo River routes both follow the full length of the wider course of the Alligator River. The Rose Bay route involves a land cut about 26.3 miles long. In Rose Bay itself considerable dredging is necessary.

13. The land cut of the Pungo River route is 20.2 miles long and runs into Wilkersons Creek, a tributary of Pungo River on the east bank. This creek is 1,400 feet wide at its mouth, where it has a channel depth of $8\frac{1}{2}$ feet, but above the mouth both the depth and width rapidly decrease. Pungo River is navigable for 25 miles above its mouth and at its mouth is over 3 miles wide and 16 feet

deep. Proceeding up the river, the width remains almost the same for some 12 or 15 miles, and the least depth of channel is 12 feet. Consequently, in Pungo River itself, comparatively little dredging is necessary, and if this route be chosen vessels while in this river can make use of a wide and fairly deep natural channel.

14. A comparison of the costs of the Rose Bay and Pungo River routes with a depth of 12 feet (the project depth between Albemarle Sound and Pamlico River) is shown in the tables below, and it is to be observed that in the length of the land cut, the total amount of dredging necessary, and the cost, the advantage is with the Pungo River route.

ROSE BAY ROUTE.

	Length of cuts (miles).	Excavation.	
		Cubic yards.	Cost.
Dredging in Alligator River.....	18.4	2,750,000	\$330,00
Cut across land to Rose Bay.....	26.3	11,991,000	1,678,74
Dredging in Rose Bay.....	3.9	617,000	74,04
Cost of right of way.....		¹ 2,600	104,00
Bridges.....			30,00
Total.....	48.6	15,358,000	2,216,78

PUNGO RIVER ROUTE.

Dredging in Alligator River.....	20.8	3,137,000	\$376,44
Cut across land to Wilkersons Creek.....	20.2	10,671,000	1,493,94
Dredging in Wilkersons Creek and Pungo River.....	3.1	590,000	70,80
Cost of right of way.....		¹ 1,969	59,00
Bridges.....			60,00
Total.....	44.1	14,398,000	2,060,24

¹ Acres.

15. With regard to the Pungo River land cut, the following should be noted:

A line was surveyed across land between the Alligator River and Pungo River, beginning as shown on the accompanying maps near Cypress Point on the Alligator River, 3¾ miles above Newport News Point and terminating at Wilkersons Creek on the Pungo. It is not thought advisable to begin the land cut farther upstream on the Alligator River, for the river soon becomes narrow and crooked beyond the above point, and while the land cut could be shortened by following the Alligator River farther upstream, the total length of the route would be increased. Many sharp bends in the river would have to be straightened, and, as the land lying to the left of the river becomes higher as one travels north, deeper and more expensive cuts would result. The initial point chosen is, therefore, considered the most satisfactory one possible, with Pungo River near Wilkersons Creek in view as a terminus for the other end of the line.

16. The land cut to the Pungo River thus surveyed consists of a single tangent 20.2 miles long, having a bearing of about south 67½° west. It intersects the narrow and tortuous but navigable portion of the Alligator River near Kilkenney Landing, about 5 miles from its north end. The line lies almost entirely in wooded

ramps, and its elevation varies from less than 1 foot above mean low water in the Pungo River to about 11.5 feet above this plane.

17. Lines of levels were run at right angles to the main line for a distance of 3 miles north of the main line and 3 miles south of the main line. It has been ascertained from these lines of levels that the ground rises slowly north of the line laid out and falls slowly on the south side of the line. It is therefore possible that a more economical line can be found south of the line surveyed, but this will be true only if the saving effected by passing through lower ground is sufficient to offset the additional cost due to lengthening the line, for, as before stated, if the chosen initial point on the Alligator River be adhered to, the line surveyed is the shortest land cut possible. The land cut surveyed will, however, answer for purposes of estimating the cost of the Pungo River route and for comparing its cost with the Rose Bay route. If economies can be effected by shifting the line 1, 2, or 3 miles to the south, this can be done after the choice of the route has been made and before the beginning of actual construction work.

SECTION C.

18. Section C extends from the line of Pamlico River to a point on the Neuse River off the mouth of Adams Creek. Throughout this section there now exists a line by a natural waterway extending around Brant Island Lighthouse and thence up the Neuse River. A second possible route proceeds from the Pamlico River to the Neuse River by a cut near Brant Island, through the long spit or shoal that extends all the way out to the lighthouse; this is the route mentioned in the report which has been formally adopted by Congress. A third alternative line extends from the Pamlico River up Goose Creek, and thence by a land cut to Jones Bay; this is the route mentioned in the report directing the present examination and survey. As was mentioned in the report on preliminary examination, this land cut to Jones Bay may be extended through to Bay River with some evident advantages.

19. In section C it was not necessary to make any surveys of the ground around the lighthouse, as all the necessary information could be obtained from Coast Survey charts. Information was also already at hand to determine the cost of the cut-off across the shoal near Brant Island. Consequently, the surveys in this section were restricted to the projected route from Goose Creek to Jones Bay and thence to Bay River, and to the route from Bay River across land to Broad Creek.

20. If the above route around the lighthouse be taken, no work and no expense is necessary in this section.

21. The cost of the second alternative line, the cut across the shoal near Brant Island so as to connect Pamlico River and Neuse River, has been already estimated at \$54,000 for the 12-foot project.

22. The land forming the peninsula between the Pamlico and Neuse Rivers is cut up by many creeks, rivers, and bays, all more or less navigable and so situated that they may be connected by short channels requiring comparatively small amounts of dredging. Some of these streams are as deep as the project now under consideration, 12 feet, while others will require some dredging.

23. Of the creeks tributary to the Pamlico River, the most desirable for this waterway is Goose Creek, and this creek is mentioned in the act directing this examination and survey. North of the Neuse River there are a number of creeks which are available—Jones Bay, the one specified in the act, Bay River, Broad Creek, and others.

24. Goose Creek is a tributary of Pamlico River on its south side about $7\frac{1}{2}$ miles from its mouth. It is a nontidal stream and its banks are low and marshy. It is navigable for boats drawing 6 feet and less to a distance of about 6 miles above its mouth. At its mouth it is about 4,400 feet wide and 13 feet deep. From its mouth to a point 1.4 miles upstream, where it is about 3,000 feet wide, the channel depths gradually decrease from 13 to 11 feet. From the 1.4-mile point to a point 3.5 miles above the mouth where it is about 2,200 feet wide, the channel depths decrease gradually from 12 to 10 feet; and from the 3.5-mile point to a point 5.5 miles above the mouth, where the stream is about 700 feet wide, the channel depths gradually diminish from 9 to 6.5 feet. In the preliminary location made for a waterway it is proposed to utilize Goose Creek as far as the 5.5-mile point, where a land line about 1.6 miles long is projected through marsh and swamp to Jones Bay.

25. For a 12-foot project, the amount of excavation necessary in Goose Creek would be about 650,000 cubic yards, place measurement, at an estimated cost of 12 cents per cubic yard, or a total of \$78,000. The length of cuts would be 5.4 miles.

26. About 1.6 miles of marsh and swamp land lie between Goose Creek and the head of Jones Bay. Two lines have been surveyed across this land. One of these lines is located with the object of terminating the sheltered part of the waterway at Jones Bay and utilizing Pamlico Sound from the mouth of Jones Bay to the mouth of Neuse River, while the second line contemplates carrying the sheltered waterway farther south to Bay River or to the Neuse River and crosses Jones Bay near its head, where it is only about 300 feet wide.

27. The first of these lines, which is the more easterly of the two, would contain 640,000 cubic yards, place measurement, for the 12-foot project, which, at 14 cents per cubic yard, would cost \$89,600 for excavation. The length of this land cut would be 1.6 miles. If a right of way 800 feet wide were purchased, 155 acres of land would have to be acquired at an estimated cost of \$30 per acre, or total cost of \$4,650 for land. One drawbridge would be required, and its cost is estimated at \$30,000. The total cost of this land cut would therefore be \$124,250.

28. The more westerly of the two lines between Goose Creek and Jones Bay is also 1.6 miles long. It would require 641,000 cubic yards of excavation, at an estimated cost of \$89,740. The cost of right of way would be \$4,650. One drawbridge, at a cost of \$30,000, would be required. The total cost of this line would therefore be \$124,390.

29. If the waterway is carried to Pamlico Sound by way of Jones Bay, dredging would be required for 2.9 miles in Jones Bay, the amount being estimated at 668,000 cubic yards. It is estimated that the cost of this work would be 12 cents per cubic yard, which would place the total cost of dredging in Jones Bay at \$80,160.

30. The outline of Jones Bay is more like that of a river than that of a bay, and like all the other tributaries of Pamlico Sound it is practically free from lunar tides, variations in the height of its water surface being almost wholly due to winds. Its current is feeble and very often no current whatever exists. With the exception of at one or two places its banks are low and marshy. At its mouth Jones Bay is about $2\frac{3}{4}$ miles wide with a channel depth of 16 feet. One mile above its mouth it is 8,000 feet wide with a least depth in its channel of 14.2 feet in the first mile above the mouth. Two miles above its mouth the stream is 7,000 feet wide and the depth of water in its second mile is very similar to the depths in the first mile. Three miles above its mouth the stream is 5,400 feet wide, and the channel depth in the third mile above the mouth varies from 13.4 to 11.4 feet. Four miles above its mouth Jones Bay is 4,000 feet wide, and in the fourth mile above its mouth the depth of water varies between 11.6 and 5 feet. Five miles above its mouth is the small village of Hooker, N. C. Here the stream is 1,600 feet wide, and the channel depth in the fifth mile above its mouth varies between 9 and 8 feet. The more easterly line from Goose Creek, discussed above, enters Jones Bay 5.7 miles above its mouth. Here the width between the banks is 1,000 feet and the channel depth 6 feet. The more westerly line from Goose Creek crosses Jones Bay 5.9 miles from its mouth, where the width between banks is about 300 feet and the channel depth about 5 feet. The cost of making this short crossing is estimated at \$2,520.

31. A short distance south of Jones Bay is a small tributary coming from Bay River. This tributary is called Beef Creek, and it empties into Gales Creek, which itself empties into Bay River.

32. A line has been run across land from near the head of Jones Bay to Beef Creek. This line is about 1.2 miles long and extends through a wooded swamp having an average elevation of $1\frac{1}{2}$ feet above mean low water.

33. For a 12-foot project this land cut requires the excavation of 89,000 cubic yards, which at 14 cents per cubic yard, would cost 68,460. The right of way would require the purchase of 126 acres of land, at \$30 per acre, or an expenditure of \$3,780 for land. No bridges would be required on this land cut, for no roads are crossed. The total estimated cost of this land cut is \$72,240.

34. After leaving the land cut, the line surveyed follows Beef Creek for a distance of 0.5 mile to its junction with Gales Creek. Beef Creek has an average width of about 350 feet, and its average channel depth is about 5 feet. After leaving Beef Creek, the route surveyed follows Gales Creek for 1.4 miles to its mouth and into Bay River. This portion of Gales Creek has an average width of about 1,000 feet and an average channel depth of about 8.5 feet.

35. The amount of dredging which would be required in Beef and Gales Creeks for a 12-foot project would be 454,000 cubic yards, and would probably cost \$54,480. If Bay River be followed to the Neuse River, no other dredging is necessary.

36. Bay River is a tributary of Pamlico Sound at its western end. It is practically nontidal, carries no sediment, and has but little current. Its channel is wide and fairly straight and it offers no difficulties to navigation. It is two miles wide at its mouth, at

which point it has a channel depth of 19 feet. Two miles above its mouth, it is 1.5 miles wide and at this point has a natural channel depth of 21 feet. Four miles above its mouth at the intersection of Gales Creek, it is again about two miles wide and has a minimum channel depth of 13 feet. Bay River has railroad communication at Vandemere, N. C., a village 8.5 miles above its mouth, where a branch line of the Atlantic Coast Line Railway has a terminal.

37. If, instead of proceeding down Bay River to the Neuse River it be desired to proceed from Bay River to the Neuse River at the mouth of Adams Creek by a more direct and sheltered route, still another cut-off may be made.

38. This other cut-off proceeds from Bay River up a tributary called Bonners Bay, and a tributary of the latter called Spring Creek, thence by a short land cut to Green Creek, thence into Broad Creek and down Broad Creek to the Neuse River. This route would require no dredging in the crossing of Bay River.

39. By this route, Bonners Bay is used for a distance of 1.6 miles to Spring Creek. Spring Creek is then followed for 0.9 mile to a point on land, the beginning of another short cut across land. Both Bonners Bay and Spring Creek have low marshy banks and have very little current. They are practically nontidal and carry no sediment. Bonners Bay is about 1.5 miles wide at its mouth, and about 0.5 mile wide where Spring Creek flows into it. The natural depth of water in Bonners Bay and Spring Creek is between 13.5 and 8.5 feet, but the channel is winding and difficult to follow.

40. For the 12-foot project, dredging would be required for a distance of 2.3 miles in Bonners Bay and Spring Creek. A total of 384,000 cubic yards would have to be removed from the two streams and at 12 cents per cubic yard the cost of this would be \$46,080.

41. In order to connect the waters of Bonners Bay and Spring Creek with those tributary to Neuse River, it is necessary to make a cut across land 2 miles long. With this object in view a line has been surveyed between Spring Creek and Green Creek. It passes through a thinly wooded swamp and some marsh. The elevation of the ground is about 3 feet above mean low water. The excavation for this land cut would be 844,000 cubic yards for a 12-foot project which at 14 cents per cubic yard, would cost \$118,160 for excavation. For right of way 191 acres of land would have to be purchased at \$30 per acre, or at a cost for land of \$5,730. The total cost of this land cut for the 12-foot project would therefore be \$123,890.

42. In order to reach deep water in Neuse River, after leaving the southern extremity of the land cut, dredging is necessary in a part of Green Creek, at the mouth of Broad Creek, and near the north bank of Neuse River. The total length of this dredging would be 2 miles. The amount of material to be dredged would be 468,000 cubic yards which, at 12 cents per cubic yard, would cost \$56,160.

43. Green Creek is a tributary of Broad Creek, near its mouth, and Broad Creek empties into the Neuse River on its north side 4.5 miles above its mouth. Both of these creeks are similar in natural characteristics to the streams flowing into Pamlico Sound. They are practically nontidal and have little current in them; they carry no sediment and are bordered by low marshy banks. Green Creek is 350 feet wide and 4 feet deep at the point where the land line from

onnors Bay and Spring Creek intersects it. The route surveyed follows it for 0.8 mile to its junction with Broad Creek, 0.9 mile from the mouth of the latter. The mouth of Broad Creek is 4,000 feet wide, and the channel depth in the part utilized by the waterway diminishes gradually from 11 to 8.5 feet. After leaving Broad Creek 0.3 mile dredging would be required in Neuse River to reach a natural depth of 12 feet.

44. In order to facilitate consideration of the relative costs of the protected portions of the waterway between the Pamlico and Neuse rivers, the costs of the three possible inland routes beginning at the mouth of Goose Creek are given below:

The shortest and cheapest of these is the route beginning at the mouth of Goose Creek and entering Pamlico Sound through Jones Bay. Its total cost is \$282,410.

The cost of the protected waterway from the mouth of Goose Creek to the mouth of Neuse River, involving two land cuts, would be \$331,630.

The cost of the protected waterway from the mouth of Goose Creek to the Neuse River at the mouth of Broad Creek, including three land cuts, would be \$557,760.

45. It will thus be seen that in section C we have as alternatives the open and exposed route outside of the lighthouse, the slightly exposed cut-off route through Brant Island Shoal, and the well-protected routes proceeding up Goose Creek and extending thence by one, two, or three land cuts, as may be considered desirable, to Jones Bay, Bay River, and Broad Creek, respectively.

COMBINATION OF ROUTES.

46. There have been discussed above the different alternative routes in sections B and C, and while the choice of routes in one section is theoretically independent of that in the other, nevertheless there are certain conditions which make the choice of route in one section dependent to some extent upon that chosen for the other.

47. Thus if the open and unprotected Croatan route be selected in section B, there is no reason why the open route around the lighthouse should not be chosen in section C, for the part of the Neuse River used in section C is no more exposed than that of Pamlico Sound in section B, and the length of unprotected route in section C is much shorter than in section B.

48. Likewise if the cut-off route by Brant Island be chosen for section C, it makes the Rose Bay route the proper one in section B, there can be no reason for cutting across the shoal near Brant Island and then proceeding back and up Pamlico Sound in section B; for use with the cut-off route in section C there can be no question as between the Rose Bay and the Pungo River routes in section B, the difference in the total length of the Rose Bay line being more than sufficient to offset its slight excess in cost over the Pungo River route.

49. Furthermore, if any one of the Goose Creek routes be selected in section C, it would follow naturally that the Pungo River route should be used in section B for the reason that the mouth of the Pungo River is nearly opposite the mouth of Goose Creek, and from Goose Creek the line up through Pungo River is both shorter and cheaper than the line up through Rose Bay.

50. We, therefore, have by combining the alternatives in sections B and C really three through routes: First, the open route from

Croatan to Pamlico Sound outside the lighthouse and up the Neuse River; second, the line through Alligator River and out through Rose Bay and thence through the cut by Brant Island and up the Neuse River (this is the present adopted route); and third, the line from Alligator to Pungo Rivers and thence up Goose Creek and thence across by one or more land cuts to the Neuse (this is the route specially mentioned in the act directing the present examination and survey).

51. The following table shows the characteristics of these different routes, the total lengths being measured from a common point in Albemarle Sound off the mouth of North River to a common point in Neuse River off the mouth of Adams Creek:

	Open route via Croatan and Pamlico Sounds.	Rose Bay route and via cut-off near Brant Island.	Routes via Pungo River and Goose Creek.		
			Jones Bay line.	Bay River line	Broad Creek line.
Total length.....miles..	117	97	115	115	115
Length of dredged cuts.....do....	8.4	23.3	32.2	31.3	31.3
Length of land cuts.....do....	None.	26.3	21.8	23	23
Length in exposed waters of Pamlico Sound and lower Neuse and Pamlico Rivers.....miles..	82	23	12	8	No
Estimated cost.....	\$183,320	\$2,270,780	\$2,342,660	\$2,391,880	\$2,618,000
Estimated cost of maintenance.....	\$50,000	\$50,000	\$40,000	\$40,000	\$50,000

COMPARISON OF ROUTES.

52. Of the alternative through routes mentioned in the preceding table, the open route through Croatan and Pamlico Sounds and the Rose Bay route have previously been considered by several boards.

53. The Croatan-Pamlico Sound route is much exposed throughout its entire length. Pamlico Sound is very wide, the shores low, and consequently its waters are exposed to the full effect of storm winds, and the water is very frequently much too rough for small boats. On account of this exposure the different boards that have considered the subject have almost unanimously recommended the protected route through Alligator River, even at an increase in cost of the waterway of approximately \$2,000,000; and of the two Alligator River routes named—the Rose Bay and the Pungo River—the Rose Bay has usually been preferred, but always in connection with a route continuing southwardly down Pamlico Sound.

54. No board has given any consideration to any of the Goose Creek lines, though, as a separate proposition and independently of the inland waterway proper, the question of a canal from Pamlico River to Neuse River by way of Goose Creek has been reported upon unfavorably.

55. If the present adopted route by way of Rose Bay, and thence down Pamlico Sound and through the cut-off near Brant Island to the Neuse River be definitely retained, vessels for a distance of over 30 miles from the time they leave the mouth of Rose Bay until they get up well in the Neuse River, will be exposed to easterly storms and waves having considerable fetch. This means for small vessels much delay and danger. In fact, it is the great length of exposure

ters that has given rise to the agitation for a change in route, which resulted in a provision being inserted in the river and harbor act affecting the present examination and survey.

56. In section B the different boards of officers have preferred a protected route over the exposed route at a cost of approximately \$1,000,000, and this preference has been approved by Congress. Analogy would therefore naturally lead to the conclusion that a protected route should be chosen for the remaining distance, especially since the cost of the most thoroughly protected of the possible routes is less than one-third of the amount paid for protection in section B. In other words, the same reasons that have led to the adoption of a protected route in section B would operate to cause one of the proposed Goose Creek routes to be chosen in section C.

57. Of the three possible Goose Creek lines—namely, the Jones Bay, Pamlico River, and Broad Creek lines—the second is preferable to the first. The cause, though the difference in cost is very small, the amount of protection gained is considerable and the navigation of vessels in the naturally broad channels of Pamlico River will be much easier than in the dredged channels of Jones Bay.

58. Of the three possible Goose Creek routes it appears to me that the Broad Creek one is by far the best. It does away absolutely with the exposure of vessels in Pamlico Sound or in the wider part of Pamlico River. The total length of the line is several miles shorter than either of the other alternative Goose Creek lines and is only about 15 miles longer than the exposed Rose Bay route. The excess of its cost over that of the Rose Bay route is only about 15 per cent of the cost of the waterway between Albemarle Sound and Neuse River, and only about $6\frac{1}{2}$ per cent of the cost of the entire waterway from Norfolk to Beaufort.

59. I therefore recommend that a change be made in the adopted route for the inland waterway and that instead of the Rose Bay line, now formally adopted, the Pungo River—Goose Creek—Broad Creek line, as above described, be selected. The estimated cost between Albemarle Sound and Neuse River is \$2,618,010 and the estimated annual maintenance \$50,000.

60. The cost of the line from Albemarle Sound to Neuse River is shown in the project adopted by Congress as \$2,270,780, which amount includes the Brant Island Shoal cut, and the total cost of the waterway is \$5,401,580. This change in the line makes an increase of \$7,230, and makes the total estimated cost of the waterway \$5,408,810.

E. EVELETH WINSLOW,
Lieut. Col., Corps of Engineers.

[First indorsement.]

OFFICE DIVISION ENGINEER,
SOUTHEAST DIVISION,
November 5, 1914.

the CHIEF OF ENGINEERS.

Referring to comparison of Rose Bay cut-off and Broad Creek line, the difference in protection may be worth the difference in cost, \$7,230, though this represents an annual interest charge at 3 per cent of \$10,416.90. This line is, however, 4.8 miles longer. This is

the most expensive of the protected routes via Goose Creek and reduces the length of channel in exposed routes from 23 miles to 10 mile. In other words, to avoid this 23 miles of exposure, 15 mile more travel is required and a yearly interest charge of about \$500 per mile of exposure saved is added.

2. Assuming for the moment that this is worth while, I will now compare the other two less costly variants (Jones Bay and Bay River lines) of the Goose Creek route with this most expensive one via Broad Creek. First, it will be noted that the annual maintenance is given as \$40,000 for each of these two as against \$50,000 for the Broad Creek route. The difference in cost between the Jones Bay and Broad Creek routes is \$275,350, which at 3 per cent gives an interest charge of \$8,260.50. This, added to the difference in annual maintenance, gives \$18,260 as the annual cost to save 12 miles of exposed water or \$1,500 per mile per year. As between the Bay River line and the Broad Creek line the difference in cost is \$226,120 which at 3 per cent gives an interest charge of \$6,783.60. This added to the \$10,000 saving in maintenance of Bay River over the Broad Creek route, gives \$16,783.60 as the annual cost of avoiding 8 miles of exposed water, or over \$2,000 per mile per year. It should be remembered that as an offset to this large difference in costs the Broad Creek line is about 3.2 miles shorter in absolute length.

3. A similar comparison between Jones Bay line and Bay River line gives: Difference in cost in favor of Jones Bay line, \$49,220, which at 3 per cent, gives an interest charge of \$1,476.60, or \$370 per mile per year to save 4 miles of exposed water.

4. Considering the relative difference in costs of the Goose Creek routes as shown above, I recommend the Bay River line. It should be noted that the 8 miles of exposed water is the 8 miles most protected of the open water included in all except the Broad Creek route and but little more exposed than the few remaining miles by all route to Adams Creek.

W. C. LANGFITT,
Colonel, Corps of Engineers.

[For Report of the Board of Engineers for Rivers and Harbors survey, see page 3.]





